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ANNOTATED BIBLIOGRAPHY OF GEOLOGICAL EDUCATION.

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ARTICLES ABOUT GEOLOGICAL EDUCATION WRITTEN DURING THE PERIOD 1919-62 ARE INCLUDED IN THIS ANNOTATED BIBLIOGRAPHY. RECOMMENDATIONS OF INDIVIDUAL EDUCATORS AND PROFESSIONAL GROUPS FOR THE UNDERGRADUATE AND GRADUATE PREPARATION OF GEOLOGISTS ARE CONTAINED IN MOST OF THE ITEMS. THE ARTICLES WERE ORIGINALLY PUBLISHED IN PROFESSIONAL JOURNALS OR BULLETINS. THEY ARE LISTED CHRONOLOGICALLY AND INCLUDE COMPLETE CITATIONS AND A BRIEF RESUME OF THE CONTENT. AN ALPHABETICAL AUTHOR LIST IS INCLUDED. THIS DOCUMENT IS ALSO AVAILABLE FROM THE AMERICAN GEOLOGICAL INSTITUTE, 1444 N. STREET, WASHINGTON, D.C., 20005, AT NO COST. (AG)

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# ANNOTATED BIBLIOGRAPHY

# OF

# GEOLOGICAL EDUCATION

by

J. Robert Berg, William W. Hambleton and John L. Snyder

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# ANNOTATED BIBLIOGRAPHY OF GEOLOGICAL EDUCATION

## PREFACE

This bibliography was first compiled in 1957 under the title "Geological Education: A Selected and Annotated Bibliography," by J. Robert Berg, as a project for the National Association of Geology Teachers and distributed in mimeograph form. With the increasing emphasis on geological education, it seems appropriate to bring the bibliography up to date and make it more readily available to those interested in this field. This has been done by William W. Hambleton and myself as a part of the GEO-Study Program supported by the National Science Foundation. As Dr. Berg points out in his 1957 introduction which follows, the bibliography is in no sense complete, nor are all of the articles of equal merit. The articles are, however, representative of what has been published in this field, particularly in the geological journals. One, the Journal of Geological Education, deals specifically with this subject and another, GeoTimes, carries one or more short articles on the educational aspects of geology in almost every issue.

John L. Snyder
American Geological Institute
January 1963

## INTRODUCTION

Geology has been defined as "the science of the earth," and as such may be considered a science in itself, whereas some authorities have defined the subject as "the application of the other sciences (i.e., physics, chemistry, biology, et al.) to the study of the earth." In some respects. geology comprised much of the subject matter that was taught in earlier days as "natural science," and is now what remains after the extraction of the other sciences from the field.

Although the field of geology in most colleges and universities is presented around a few standard and time-worn courses, there is a trend toward specialization and proliferation that has plagued many other fields, e. g. engineering. In some institutions, the area of geology is considered a college, school, or division, consisting of several departments, notably the Division of Earth Sciences at Stanford University, and the College of Mineral Industries at Pennsylvania State University. At the latter institution, the "college" is subdivided into three divisions, consisting of 12 departments. At many schools the standard title is the "Department of Geology and Geography". At other schools the department or division embraces the subjects of ceramics, meterology, astromony, metallurgy, mining, and other fields; there has also been considerable emphasis in recent years, upon the subjects of geophysics and geochemistry.

The problems of these diverse practices have resulted in the creation of many committees to study geological curricula, and the publication of numerous articles, recommending emphasis in various supporting fields.

In an attempt to bring together some of the more significant articles on this problem, it was decided that their presentation in chronological sequence, would serve to better advantage for the student of the problem. This would also serve to group together the efforts of certain committees which operated over a few years span, and whose material might be related more clearly in this manner, than in the usual alphabetical presentation.

The contained bibliography does not pretend to be complete.

J. Robert Berg,
Department of Geology,
University of Wichita, Kansas
1957

NOTE: Cross reference between this chronologic listing and an alphabetical listing, by author and date, is provided by a supplementary alphabetical listing of authors and reference numbers.

1. Lindgren, Waldemar, (1919). "Economic geology as a profession," Economic Geology, v. 14, p. 80-86.

   For economic geology as a profession, the author recommends more laboratory and field work in geology, an engineering-like background, with more mathematics (including statistics), physics, and chemistry (including organic). Some background is desirable in hydrology, soil mechanics, agriculture, political economy, and international trade; recommended language preparation should include French, German, Italian, Spanish, Russian, and Arabic.

2. Leith, C. K., (1921), Economic Aspects of Geology, Holt and Co., New York, Ch. XXI, "The Training, Opportunities, and Ethics of the Economic Geologists", pp. 420-431.

   For an article written 36 years ago, we find herein some familiar statements reiterated by students of curricula today. Leith stated that "The best results have been obtained from students who, before entering geology, had a broad general education, or who have followed intensively some other line of study." A plea for more mathematics and science is substantiated by his statement that "Geology is passing from the descriptive and qualitative stages to a more precise basis."

3. Shuler, Ellis W., (1929), "Ungraduate preparation for the geologist," Bulletin, American Association of Petroleum Geologists, v. 12, no. 10, pp. 1317-1322.

   An early concern is shown for the subject, decrying the specialization and diversification of geology courses. A survey of 100 geologists recommended from 36 to 42 hours of fairly standard courses, emphasis upon mathematics, and allied sciences, a foreign language, and English.

Courses and Hours Most Frequently Mentioned in Survey, (Shuler)

| | | | |
|---|---|---|---|
| Gen'l Geol. (presum. incl. Hist.) | 6 | Field Geol. | 3-6 |
| Mineralogy | 6 | Stratigraphy | 3 |
| Petrology (Rocks and Rock Min.) | 3 | Sedimentation | 3 |
| Structural | 3 | Petroleum | 3 |
| Paleontology | 3-6 | Adv. Gen'l Geol. (Physiogr. or Geomorph. incl.) | 3-6 |
| Economic | 3 | | |

Some Sample Schedules at Different Schools

| | | | | |
|---|---|---|---|---|
| Gen. Geol. (incl. Hist.) | 6 | 6 | 6 | 6 |
| Mineralogy | 6 | - | - | 6 |
| Rocks and Minerals or Petrology | 3 | 3 | 3 | 3 |
| Structural | 3 | 3 | - | - |
| Paleontology | - | 3 | 3 | 6 |
| Economic | 6 | - | - | 6 |
| Field Geology | 6 | 3 | - | 6 |
| Stratigraphy | - | 3 | 3 | - |
| Sedimentation | - | - | 3 | - |
| Petroleum | - | 3 | - | - |
| Physiography | - | - | 3 | - |
| Historical (Adv.?) | - | - | 3 | - |

4. Lahee, F. H., (1938), "Where shall our young graduates in petroleum geology acquire field experience?", Bulletin, American Association of Petroleum Geologists, v. 22, pp. 1613-1614.

Concern is expressed for the subject of and experience in field geology, which is not acquired in the normal classroom situation, nor in company employment in many cases.

5. Levorsen, A. I., (1940), "Petroleum geology," Bulletin, American Association of Petroleum Geologists, v. 24, no. 8, pp. 1355-1360.

In the introductory article to a series of six papers in this issue, entitled "Symposium on New Ideas in Petroleum Exploration," it is pointed out that in petroleum geology the dominant trend seems to be toward emphasis upon stratigraphy, sedimentation, and historical geological.

6. DeGolyer, E. L., (1940), "Future position of petroleum geology," Bulletin, American Association of Petroleum Geologists, v. 24, no. 8, pp. 1389-1399.

This is the sixth of the articles in the symposium mentioned above. DeGolyer states that a petroleum geologist must be essentially a geological engineer; training in field geology is a necessity as an educational measure. Geophysics must not be regarded as a distinct and separate subject from geology; its value is only as great as the interpretations of physical measurements in terms of structural geology.

* * * * * *

The next series of four articles represents the reports of an American Association of Petroleum Geologists "committee on

college curricula." The titles listed are actual. It may be noted that in the second report the term "special" is dropped from the committee designation, and, in the last two reports, the phrase "in petroleum geology," is added to the titles, whereas, in reality, the latter two deal with geology and warfare.

7. American Association of Petroleum Geologists, (1941), "Report of Special Committee on College Curricula," Bulletin, American Association of Petroleum Geologists, v. 25, no. 5, pp. 969-972.

The first in a series of four committee reports, is based on a survey of oil company and consulting geologists, and a comparison with the offerings listed in college catalogs. Insufficient grounding in the basic subjects of mathematics, physics, chemistry, and English is noted. Too specialized training in a few branches of geology that apply directly to oil exploration does not produce as efficient petroleum geologists as a broader foundation in all the main branches of the science. Also emphasized are botany, zoology, field mapping, geophysics, logic, and a foreign language.

8. American Association of Petroleum Geologists, (1942), "Report of Committee on College Curricula," Bulletin, American Association of Petroleum Geologists, v. 26, no. 5, pp. 943-946.

The second report deals with specific curricula and a survey of 70 geological departments, reiterating some of the points in Report No. 1, and also emphasizing the necessity of a 5-year program. The following courses were recommended:

| Required Geology Courses | | Elective Geology |
|---|---|---|
| Introductory (Struct.) | Economic Geol. | Crystallography |
| Historical Geology | Field Geology | Petrography |
| Mineralogy | Stratigraphy | Micro-paleontology |
| Petrology | Sedimentation | Mineral Deposits |
| Physiogr. or Geomorphology | Petroleum Geol. | Engineering Geol. |
| Structural (Adv.) | Princ. of Geophysics. | Photogrammetry |
| Invert. Paleontology | | |

Courses in addition to geology

| Math. and Sci. | Communications | Engineering |
|---|---|---|
| Mathematics through Calculus | English Comp. | Mech. Drawing |
| Physics | Foreign Language | Descriptive Geom. |
| Qual. and Quant. Chemistry | Public Speech | Surveying |

Courses in addition to geology (Concluded)

| Humanities and Soc. Sci. | Some Recommend | |
|---|---|---|
| History | Biology | Differential |
| Economics | Organic Chemistry | Equations |
| Political Sci. | Phys. Chemistry | Mechanics |
| Sociology | Advanced Physics | Hydraulics |


9. American Association of Petroleum Geologists, (1943), Report of Committee on College Curriculas, : Bulletin. American Association of Petroleum Geologists, v. 27, no. 5, pp. 694-697.

Responses from industry and colleges are based upon data in Report No. 2; military geology and its value is also discussed.

10. American Association of Petroleum Geologists, (1944), "Report of Committee on College Curricula in Petroleum Geology, "Bulletin, American Association of Petroleum Geologists, v. 28, no. 5, pp. 670-675.

A further study of the applications of geology in warfare, and the problem of accelerated programs occasioned by the war are the subject of this report.

11. Boutwell, John M., (1945), "Economic Geology" (Presidential Address before the Society of Economic Geologists), Economic Geology, v. 40, no. 7, pp. 431-448.

Preparation should be based on a broad general college courses, including literature, economics, history, business, mathematics, and other sciences. An intensive study of geology should not begin until late in undergraduate or preferably in graduate school.

12. Taylor, Ann Richards, (1946), "Geology as a profession, " Vocational Booklet No. 1, National Roster of Science and Special Personnel, and U. S. E. S., Dept. of Labor, pp. 14-16.

A section of "Training" in this booklet lists the recommended pre-college training and the minimum recommendations in geology, in mathematics and related sciences, and in background and related courses.


Pre-College (in high school)

| | |
|---|---|
| Mathematics (through solid geom. ) | 2 Modern Languages |
| Biology | Advanced English |
| Physics | Geography |
| Chemistry | Drafting-surveying |

| Required College Level | |
|---|---|
| Gen'l Geol. | 1 yr. |
| Mineralogy | 1/2 yr. |
| Rock types | 1/2 yr. |
| Historical | 1/2 yr. |
| Paleontology | 1/2 yr. |
| Structural | 1/2 yr. |
| Economic | 1/2 yr. |
| Mapping and Technique | 1/2 yr. |

| Science and Mathematics | |
|---|---|
| Math. to incl. Trig. and Calc. | |
| Biology | 1 yr. |
| Physics | 1 yr. |
| Chemistry | 1 yr. |

Related Fields

Mining, Hydraulics
Geophysics, Elect. & Magnetism

Background Courses

Two Modern Languages
English
Economics
Political Science

* * * * * *

The following series of conferences and committee reports are the result of a suggestion made in December 1945, by Dr. H. R. Aldrich, Secretary of the Geological Society of America. Although several other committees were later organized, under the auspices of different organizations, all of the reports of this series were published in the Interim Proceedings of the Geological Society of America. The foreword to the first conference reiterates some of the earlier recommendations of the American Association of Petroleum Geologists reports. In addition, an accrediting system is recommended, "with minimum requirements for admission of a teaching department into the accredited list"; however, care should be exercised so that such requirements do not exclude small departments, many of which have unusually excellent records in training of geologists.

13. Gilluly, James, (1946), "The training of geologists," Interim Proceedings, Geological Society of America, pt. 2, March, pp. 3-8.

The author recommends about 40 hours of basic courses in geology, 32 hours of other sciences and mathematics, and about one-third of the curriculum for the humanities and social studies; faculty teaching loads light enough to allow research; and a staff of at least three teachers.

| | | | | | |
|---|---|---|---|---|---|
| Gen'l Geol. | 6 | Surveying and Field Geol. | 10 | Mathematics (through Calc.) | 15 |
| Mineralogy | 4 | Elective Geology (preferably subordinated to further work in mathematics, physics, and chemistry.) | 6 | Descriptive Geometry | 2-3 |
| Petrology | 4 | | | Foreign language (German or Russian) | |
| Paleontology and stratigraphy | 6 | | | | |
| Structural | 4 | | | | |

1/3 (40) hours of college studies for humanities and social studies.

Graduate

Microscopical Petrography
Economic Geology
Metamorphism
} Should not displace fundamental and basic science courses.

Accrediting Tests

At least staff of three teachers. Teaching loads must allow research time.

14. Levorsen, A. I., (1946), "Desirable training for petroleum geology, : Interim Proceedings, Geological Society of America, pt. 2, March, pp. 8-12.

The author quotes largely from the American Association of Petroleum Geologists reports mentioned earlier, and also recommends a 5-year program, or one to two years of advanced study (presumably graduate).

15. McKinstry, H. E., (1946), "Desirable training for mining geology," Interim Proceedings, Geological Society of America, pt. 2, March, pp. 12-19.

After discussing the responses to a survey of geologists, the author points up the difficulties of obtaining the requirements of geology, engineering, business and the liberal arts in a 4-year period.

16. Delo, David M., (1946), "Better teaching - a geologic necessity," Interim Proceedings, Geological Society of America, pt. 2, March, pp. 24-27.

The setting up of a required curriculum alone will not insure a good product; many of the small colleges with a single staff member and other limitations have produced some of the more notable geologists. Hence, the plea is more for "better teaching," than a series of requirements. This article is followed (pp. 27-53) by comments of conference participants on curriculum problems. The results of Delo's survey are as follows:

Recommended Curriculum

| Course | Sem. Hrs. | Course | Sem. Hrs. |
|---|---|---|---|
| Physical Geology | 4 | Economic Geology | 4 |
| Historical Geology | 4 | Paleontology | 4 |
| Mineralogy | 4 | Physiography or Regional Geol. of North America | 4 |
| Petrology | 4 | Field Geology | 6 |
| Structural or Geomorphology | 4 | Senior Thesis | 2 |

Teachers, less than 1-1/2 per department, most one man
(Based on survey of 14 schools)

| | | | | | |
|---|---|---|---|---|---|
| California | 1 | Iowa | 1 | Ohio | 2 |
| Colorado | 1 | Kentucky | 1 | Pennsylvania | 1 |
| Illinois | 3 | Minnesota | 1 | Texas | 1 |
| Indiana | 1 | | | Wisconsin | 1 |

17. Longwell, C. R., (1946), "Second Conference on Training in Geology," (called by Nat'l Research Council committee under auspices of the American Association of Petroleum Geologists), Interim Proceedings, Geological Society of America, pt. 4, June, pp. 1-39.

Three principal conferees presented papers: (two of which follow):

Hubbert, King L.: Hubbert discussed chronological developments of geology from the natural science phase, and reasoned that a curriculum might be organized in the same manner. He feels that sufficient time is available in the 4-year program, unless students are loaded down with unnecessary information.

Delo, David M.: The small and liberal arts colleges were surveyed for a summary of their undergraduate major data, which is presented in tabular form, separated into geology and collateral courses; this is followed by an undergraduate major proposed by the author.

18. Longwell, C. R., (1946), "Third Conference on Training in Geology," (called by Nat'l Research Council under auspices of the American Geophysical Union), Interim Proceedings, Geological Society of America, pt. 5, July, pp. 1-26.

This commentary, by 21 conferees, is concerned largely with training in geological engineering and geophysics.

19. Smith, H. T. U., (1947), "Use of aerial photographs in geology," Fourth Conference on Training in Geology, Interim Proceedings, Geological Society of America, pt. 1, March, pp. 2-7.

The use of aerial photographs as a teaching aid in many courses in geology is emphasized.

20. Colbert, Edwin H., (1947), "A paleontologist's view of the geology curriculum," Fourth Conference on Training in Geology, Interim Proceedings, Geological Society of America, pt. 1, March, pp. 8-14.

A comparison is given on the amounts of mathematics, physics, and chemistry, required at most colleges (at least 1 year of each) for the geology major, and the lack of, or few hours required in the field of biology.

21. Quirke, Terrance T., (1947), "Geology for engineers," Fourth Conference on Training in Geology, Interim Proceedings, Geological Society of America, pt. 1, March, pp. 16-23.

The value, content, and problems of a course in geology for engineers is discussed.

22. Melton, Frank A., (1947), "Proposed monograph of historical geology and the geological education controversy," Fourth Conference on Training in Geology, Interim Proceedings, Geological Society of America, pt. 1, March, pp. 49-58.

As indicated by the following table of contents, this paper is one of the most comprehensive and searching of this series:

1) Criticisms of geological education.
2) Is Geology a unique science or the application of other sciences to a study of the earth?
3) Faculty competence.
4) The issue of standardization: danger of accrediting power.
5) Advanced level monographs of historical geology.

23. McKinstry, H. E., (1947), "Review of previous conferences on training in geology," Fifth Conference on Training in Geology (American Association of Advancement of Science in cooperation with the Geological Society of America), Interim Proceedings, Geological Society of America, pt. 1, March, pp. 62-65.

A review and summary of papers and comments from previous conferences of this series.

24. Hemingway, Caroline E., (1947), "Training of women in geology," Fifth Conference on Training in Geology, (American Association of Advancement of Science in cooperation with the Geological Society of America), Interim Proceedings, Geological Society of America, pt. 1, March, pp. 66-71.

This article includes a survey of women geologists, the organizations in which they are employed, a recommended curriculum in geology, and supporting courses in the sciences and other fields.

25. Lougee, Richard J., (1947), "Cultural versus the professional approach to geology for college students," Fifth Conference on Training in Geology, (American Association of Advancement of Science in cooperation with the Geological Society of America), Interim Proceedings, Geological Society of America, pt. 1, March, pp. 71-74.

This paper emphasizes the cultural and non-professional approach not only for the beginning courses in geology but also for advanced courses on the college level, recommending specialization and the professional approach for graduate studies.

26. Adkins, John N., (1947), "Training the geologists for geophysical work," Fifth Conference on Training in Geology, (American Association of Advancement of Science in cooperation with Geological Society of America) Interim Proceedings, Geological Society of America, pt. 1, March, pp. 77-80.

Emphasizes the recognition of geophysics as a subdivision of geology rather than a separate or borderline science.

27. Bradley, W.H., (1947), "A suggested geological curriculum," Interim Proceedings, Geological Society of America, pt. 2, April, pp. 8-13.

This is a report prepared by a committee of U. S. Geological Survey Geologists. It is a recommendation prepared for the department of George Washington University (D. C.), and includes courses in geology (27 hrs.) supporting science and mathematics, a two-fold option for physical vs biological geology majors, other liberal arts courses, and recommendations for a graduate program.

28. Longwell, C. R. (Chmn.), (1947), "Final report and recommendations of the Committee on Geological Education, Division of Geology and Geography, Nat'l Research Council," Interim Proceedings, Geological Society of America, pt. 3, August, pp. 16-20.

Recommendations include:

1) Wider recognition of geology in general education and in high school programs;
2) Revision of curricula to include more science and mathematics;
3) Revision of teaching techniques away from descriptive and authoritarian techniques and toward those which incite scientific curiosity and rigorous thinking; and
4) Greater proficiency in foreign languages. There is also a suggestion of an educational journal for geology.

29. American Association of Petroleum Geologists, (1948), "Report of Committee on Education," Morse, Roy R. (Chmn.), Bulletin, American Association of Petroleum Geologists, v. 32, no. 6, June, pp. 1197-1199.

A review is presented of the work of other committees, with which the American Association of Petroleum Geologists has cooperated, and an endorsement of their cooperative findings is emphasized. One recommendation goes further, stating ". . . that this requirement (that of other science and mathematics), where necessary, take precedence over such courses in geology as those dealing in specialized techniques rather than fundamentals." Opposition is stated against any present attempts of further accreditation of schools. A continuing committee on geologic education is recommended.

30. Hendricks, Thos. A., (1948), "The significance to the Geological Survey of accreditation of schools in geology", Joint Conference of the (Geological Society of America), Committee on Geological Education and the Association of Geology Teachers, Interim Proceedings, Geological Society of America, pt. 2, March, pp. 7-10, (and comment 10-16).

The U. S. Geological Survey, the largest single employer of geologists in the country, presents the pros and cons of accreditation from the Survey viewpoint. Comment by A. L. Howland (Association of Geology Teachers president, Central Section), states that a survey of geology teachers indicates that two-thirds in favor of some type of accrediting, but states personnel is most important, with curriculum second, and facilities third. Comment by O. R. Grawe emphasizes difficulty of teaching geology in a "school of mines" where other curricula are accredited. Comment by J. Singewald, "Geology, as we all know, is but the application of mathematics, physics, chemistry, and biology, (to the study of) the particular object, the earth", hence, all these fields must be considered in accrediting.

31. Fryxell, F. M., (1948), "Accreditation and the liberal arts college," Joint Conference of the (Geological Society of America) Committee and the Association of Geology Teachers, Interim Proceedings, Geological Society of America, pt. 2, March, pp. 16-21 and commentary, pp. 21-37.

The unusual record of the small libe. l arts college is cited, along with the names of some of their eminent products. Major

requirements often include no more than a minimum of 24 hours in geology, but with a liberal amount of specified supporting courses in mathematics, other sciences, and foreign language; these are some of the very recommendations made by previous committees. The past record and pattern of the small liberal arts college speaks well for a plan of graduate school preparation. An additional value of the liberal arts colleges is the fact that teaching is generally of high quality, with even the elementary courses being taught in small classes, by one of assistant to full professor rank, thus maintaining the close teacher-student relationship.

32. Theil, Geo. A. (Chmn.), (1949), "Report of the Committee on Geological Education of the Geological Society of America," Interim Proceedings, Geological Society of America, pt. 2, July, pp. 17-21.

The summary and conclusions or final report of the committee appointed in December 1946: The committee feels that the present problem is one of transition from where we are (in a natural history phase) to a new destination which we hope to reach in the near future. Recommendations include one year of communications, one-half year of drafting, two years of one or more foreign languages, mathematics through calculus, chemistry through physical, two course years of physics; in geology, three and one-half course years devoted predominantly to general, mineralogy, petrology, and field geology. Some recommendations are also made for graduate training.

33. Horberg, C. L., Olson, E. C., and Thiel, G. A. (Chairmen for Committees), (1950), "Geology curriculum in the liberal arts college," by Committee on Curriculum and Standards, Association of Geology Teachers; Committee on Geological Education, American Geological Institute; and Committee on Geological Education, Geological Society of America; Interim Proceedings, Geological Society of America, pt. 2, July, pp. 9-17.

This report reviews and endorses many of the recommendations of the above report (Theil, 1949) with respect to the liberal arts college. It is stated that the geology curriculum is comparable in purpose to the premedical or predental courses, and quite different from the chemistry major. Some of the problems of geology arise from the fact that not more than a fraction of the universities and colleges have departments of full-time status, and virtually no secondary schools teach the subject. Departments with the best records have avoided multiplication of courses.

Recommendations are similar to those in the 1949 report but differ in recommending a minimum of one course year each of chemistry and physics, with electives for further study. The beginning course in geology should merit the best teaching talent.

34. Chapman, Randolph W., (1951), "The training of geologists in Great Britain," Interim Proceedings, Geological Society of America, pt. 1, March, pp. 17-35.

As a result of a Fulbright grant in 1949, the writer lectured at several institutions in Great Britain. This paper presents a comprehensive survey of the curricula at several schools, and a comparison with American educational patterns. Notable in Great Britain is the more limited field of employment, the greater emphasis on field experience, the greater use of technicians to aid the university professor, and substantial government aid.

* * * * *

The remaining series of articles is largely miscellaneous in nature, being published by individuals in a variety of periodicals, rather than as a result of a committee effort. However, several of the papers are published in the Journal of Geological Education, a publication whose very purpose is in part the study of this problem, and whose initiation was often suggested in some of the earlier committee reports.

35. Bannerman, H.M. and Pecora, Wm. T., (1950), "Training geologists: A U.S. Geological Survey viewpoint," U.S. Geological Survey Circular No. 73, Washington, D.C., March 1950.

For a survey career, the student is best suited who is well grounded in physics, chemistry, mathematics, and biology, before concentrating on any specific field in geology. At least two years should be devoted to graduate study. Irrespective of the specialities they may eventually follow, students should have a sound training in mineralogy, petrography, petrology, stratigraphy, structure, paleontology, geomorphology, map interpretation, and construction, the latter to include the elements of surveying, drafting, and photogrammetry.

36. Albritton, Claude C., Jr., (1962), "Historical approach to the problem of training geologists," Field and Laboratory, v. XXI, June, no. 1, pp. 13-20.

A review of the recommendations presented in the Interim Proceedings . Geological Society of America and other publications,

compares such suggested curricula with that of Southern Methodist University. A survey of graduates of Southern Methodist University, portrays their success, present positions, and careers as evidence for the worth of the type of curriculum given at Southern Methodist University.

37. Gault, H.R., (1952), "Changing requirements in chemistry, physics, and mathematics for geology majors, "Journal of Geological Education, v. 1, no. 3, pp. 13-17.

A summary of various schools, geographically and by type (19 in number), shows the increasing number of course years required in other areas.

| | 1935 | 1940 | 1945 | 1950 |
|---|---|---|---|---|
| Chemistry | .92 | .97 | 1.10 | 1.26 |
| Physics | .47 | .55 | .66 | .71 |
| Mathematics | .61 | .71 | .82 | .92 |
| Total | 2.00 | 2.23 | 2.57 | 2.89 |

38. Behre, Chas. H., Jr., (1953), "The college geology teacher," Journal of Geological Education, v. 1, no. 5, pp. 11-25.

Behre discusses the fine attributes of the college teacher versus the technical school or graduate school teacher, the curriculum, and the importance of summer field experience.

39. United States National Science Foundation, (1953), "Report of the National Science Foundation-Beloit Conference on Geologic Research in Colleges," Beloit College, pp. 1-16.

The report of a conference sponsored by the National Science Foundation included representatives of 30 colleges. Research possibilities in the smaller college might be enhanced by additional scholarships, support for field training, and additional equipment and library facilities.

40. McCaslin, John C., (1954), "Give us better trained geologists", Oil and Gas Journal, July 12, 1954, pp. 146-148.

As an example of the better training now offered by American colleges and universities, the curricula at the University of Kansas is set forth as an example, requirements for the B.S. in Geological Engineering are listed.

41. Horberg, C. L., (1955), "Current trends in geology and their relations to geological education," Journal of Geological Education, v. 3, no. 1, pp. 1-6.

Several trends in geology are discussed, including, specialization into sub-sciences, the adoption of methods of the basic sciences, the expansion of research, vocationalism, loss of teaching personnel to government and industry, and the forthcoming large enrollments. Suggested solutions include unification of subject matter, a decrease in the teaching of applied geology, provision for training both specialized and general geologists, more rigorous standards, and efforts upon the part of all concerned to keep geology teachers in the profession.

42. Ellison, Samuel P., Jr., (1955), "Costs of geological education," Bulletin, American Association of Petroleum Geologists, v. 39, no. 8, pp. 1652-1655.

This paper presents a survey of costs per credit hour in geology, in comparison with the other sciences, in 90 representative colleges and universities. Costs range from a low of $3.59 to a high of $200.19 per student credit hour, with an average cost of $16.25. Costs were also given over a period of 4 years in comparison with biology, chemistry, and physics; the average range for all of these sciences is from about $15.00 to $23.00 per student credit hour, with physics usually the highest, and biology usually the lowest.

43. United States Department of Labor, (1955), "Educational requirements for employment of geologists," V. A. Pamphlet 7-8.5, prepared by Bureau of Labor Statistics, Dec., pp. 1-11.

Degree requirements, statistics, and employment possibilities are listed, followed by a statement of general qualifications. The latter includes training in each of the fundamental geologic disciplines supplemented by a knowledge of physics, chemistry, mathematics, biology, and engineering. The student must also know the techniques of surveying, map making, note-taking, specimen collecting, and training in laboratory methods. Knowledge of a foreign language is desirable, and an acquaintance with economics and business administration prepares employees for advancement into responsible positions in industry.

44. Foose, Richard M., (1956), "The humanities: An antidote for over-specialization in geologic science," Journal of Geological Education, v. 4, no. 1, pp. 9-12.

Emphasizes in a general discussion the need for the humanities in the geological curriculum.

45. Bullard, Fred, M., (1956), "Is there room for liberal education courses in the geology curriculum?", Journal of Geological Education, v. 4, no. 1, pp. 13-15.

The question raised by the title of this paper brings up four possibilities, namely:

1) lengthen the period of study to five years;
2) leave out some of the geology courses to make room for the liberal education courses;
3) set up entrance requirements so that most of the general education courses would be taken in high school; and
4) some combination of the above.

46. Cohee, George V., (1956), "General education in retrospect," Journal of Geological Education, v. 4, no. 1, pp. 16-18.

The writer was presented in his own school with the problem of integrating a program of general education with geology requirements at a time when the oil industry was requiring a minimum of 50 hours of geology before considering an applicant for employment. The difficulties of doing so and at the same time, including the necessary mathematics and related sciences is described.

47. Foose, Richard M., (1956), "Geologic education," GeoTimes, v. 1, no. 6, p. 9.

This paper is essentially a report on the "Symposium of Geologic Education," and the papers presented therein, at the annual meeting of the Association of Geology Teachers, held in conjunction with the Geological Society of America at Minneapolis, November, 1956, some of which follow.

48. Croneis, Carey, (1956), "Problems of geological education and of educating geologists," Bulletin, American Association of Petroleum Geologists, v. 40, no. 12, pp. 2961-2970.

This paper is the most comprehensive recent report on the subject of the problems of getting and holding teachers of geology. A survey of salaries, intangible rewards, and a ranking of schools on different bases is presented.

49. Boardman, Donald C., (1957), "Correlating the geology curriculum with the general education requirements of the college," Journal of Geological Education, v. 5, no. 1, pp. 1-3.

A survey of a large number of college catalogs indicates average general education requirements as (in sem. hrs) English Language and Composition, 12; Literature, 8; Social Science, 10; Humanities, 12; Foreign Lanugage, 16. Such requirements must be correlated with the geology curriculum in order to assure their value to the student in his geologic training.

50. Hussey, Keith M., (1957), "Applied courses will limit our products' potential," Journal of Geological Education, v. 5, no. 1, pp. 4-5.

Over-specialization on the undergraduate level limits a student for either graduate or commercial work, because such courses are often taken at the sacrifice of more basic or fundamental courses.

51. Hendriks, Herbert E., (1957), "Basic science and mathematics requirements in the geology curriculum," Journal of Geological Education, v. 5, no. 1, pp. 6-10.

From a report based on surveys, geology major requirements include: chemistry by 87 percent, of schools surveyed; mathematics 77 percent; physics 74 percent; biology 23 percent; mechanical drawing or drafting 19 percent; and Civil engineering or Surveying 17 percent. The following numbers of hours appear adequate to achieve goals: chemistry 10-12 hours; mathematics 8-10 hours; biology 6-8 hours; physics 8-10 hours; drafting 6; and surveying 6.

52. Howell, B. F., Jr. (1957), "Preparation for graduate school - A study based on the needs of geophysicists, and geochemists," Journal of Geological Education, v. 5, no. 1, pp. 11-18.

An emphasis is placed on more mathematics, physics, and chemistry, even at the sacrifice of extra geology courses for the student planning to enter Geophysics or Geochemistry.

53. Langenheim, Ralph L., Jr., (1957), "Language requirements and other regulations for graduate study in geology," Journal of Geological Education, v. 5, no. 1, pp. 19-22.

Forty of 92 departments surveyed do not require a language for the M. S. degree; all but 11 require two languages for the Ph. D. degree. Northeastern schools are most rigid, whereas north-central schools are most lax in the language

requirement. The requirements of preliminary and final examinations for advanced degrees is also presented.

54. Laird, Wilson M., (1957), "Let's train our geologists," GeoTimes, v. 1, no. 12, June, pp. 14-15.

A recommended curriculum includes:

| Geology | Basic Science |
|---|---|
| General Geology | General Chemistry |
| Mineralogy, including Optical | Qual. and Quant. Analysis |
| Petrology | Physical Chemistry |
| Structural | Physics |
| Geomorphology | Mathematics through Calculus |
| Paleontology | **Humanities*** |
| Sedimentology | English |
| Stratigraphy | Speech |
| Economic Geology | History |
| Thesis and Seminar | Economics |
| Field Geology ( at least one summer) | Political Science |
| | Foreign Language |

* An error of nomenclature is noted here and also under the 1942 American Association of Petroleum Geologists, report. It must be noted that none of these courses, (except history), are actually in the field of the Humanities, which by definition, "humanities includes any and all literature, philosophy, music, architecture, drama, ballet, painting, and quite frequently religion and history", per Dressel, P. L., and Mayhen, L. B., General Education, American Council on Education, 1954.

55. Cooper, Byron N., (1958), "Research and effective teaching in the geological sciences," Journal of Geological Education, v. 6, no. 1, pp. 15-18, Spring.

Most geology teachers poll somewhere between the end points of teacher and researcher. An optimum ratio is difficult to determine, and is not so important in the individual as it is in the department as a whole. This number of the Journal of Geological Education contains papers from symposium on teaching and research given at the National Association of Geology Teachers meeting, Atlantic City, 1957. Papers by C. G. Higgins, Lloyd Staples, Ian Campbell, Byron Cooper, Grover Murray.

56. Murray, Grover, E., (1958), "Some relations of teaching and research in geology," Journal of Geological Education," v. 6, no. 1, pp. 19-20, Spring.

A poll of graduate students at Louisiana State University to select the best teachers, shows that 67 percent of "the best" had research in progress as against 40 percent for faculty as a whole. Concludes productive researchers are more likely to be good teachers.

57. Harbaugh, John W., (1958), "Stanford's School of Mineral Sciences get critical review," GeoTimes, v. III, no. 3, pp. 8-9, Sept.

A tabulation of suggestions made to a committee of Stanford alumni and friends for the improvement of the school of mineral industries.

58. Ecklemann, F. Donald, (1958), "Physical geology integrated with general chemistry," Journal of Geological Education, v. 6, no. 2, pp. 3-5, Fall.

Describes a course in physical geology that has as a pre-requisite, one semester of chemistry. Allows many geologic topics to be studied in a more quantitative way.

59. Ginger, Lyman G., and others, (1958), "Science, mathematics and the humanities: Let's balance the program," National Education Association Journal, v. 47, pp. 79-90, Fall.

This article emphasizes the necessity of building science on the humanities.

60. Socolow, Arthur A., (1958), "Bread and butter courses may be fattening," Journal of Geological Education, v. 6, no. 2, pp. 1-2, Fall.

Introductory geology course should be a "show-piece" with a wide intellectual appeal, rather than just a well populated money maker. Choice of instructor is important.

61. Brown, F. Martin, (1959), "Earth science training inadequate," GeoTimes, v. III, no. 6, pp. 10-11, March.

A study of 203 teachers of general science showed they were distributed as follows in terms of their background in Earth Science courses (including geography).

| Hours | Percent | Hours | Percent |
|---|---|---|---|
| None | 46.2 | 9-11 | 4.9 |
| 1-2 | 5.4 | 12-20 | 5.4 |
| 3-5 | 22.2 | 21-29 | 2.5 |
| 6-8 | 12.3 | 30 and over | 1.0 |

62. Behre, Chas. H., (1959), "Problems of the geology teacher and his association," Journal of Geological Education, v. 7, no. 1, pp. 13-17, Spring.

Address on receiving the Neil Miner Award. Speculates on some of the problems of the geology teacher: How to improve standards, prevent oversupply, and determine what will be the necessary courses of the future. A plea for planning.

63. Hagner, Arthur F., and Henderson, Donald M., (1959), "Problems in geologic education, the elementary course," Journal of Geological Education, v. 7, no. 1, pp. 36-39, Spring.

The elementary course should emphasize thinking processes and concepts. Several major concepts such as "The extreme age of the earth, and the progressive nature of biological change should be well emplaced in the students' mind.

64. Stevenson, Robert E., (1959), "Geology in an academic year institute," GeoTimes, v. IV, no. 1, p. 15, July-Aug.

Brief description of the program for geology majors of the 1958-1959 Academic Year Institute held by the State University of South Dakota.

65. Fan, Paul H., (1959), "Developing a better geological profession," GeoTimes, v. IV, no. 4, p. 26, December.

Suggests the elimination of geology as an undergraduate major. Students would major in biology, chemistry or physics and then do graduate work in geoscience.

66. Charlier, D.H., and Daley, C.J., (1960), "Requirements in geology departments," Bibliog. Sch. Sci. and Math., v. 60, pp. 291-298, April.

Authors surveyed 58 geology departments to find out what courses were needed for graduate work. Findings are tabulated. Also a strong plea for geology courses in secondary school. Cites several examples where a practical knowledge of geology would have been very useful.

67. Willard, Gates, (1960), "A new roll [sic] for the graduate geologist," GeoTimes, v. IV, no. 8, pp. 14-34, May-June.

A 9th grade course in earth science shows the interrelationship between a number of scientific disciplines. Earth science teaching is a possible new field for geologists.

68. Croneis, Carey (1961) "Geological perspective," Journal of Geological Education, v. 9, no. 1, pp. 1-12.

This is a presidential address to the National Association of Geology Teachers. The author briefly surveys the role of man in his physical environment past, present, and future. Such problems as the tremendously increasing rate of energy consumption, whether or not man is biologically unique, and the possible causes and effects of overpopulation are considered. He concludes that although many such problems have little to do with classical geology, this should not prevent geologists and geology teachers from considering them. In short, widely ranging philosophical reviews are the prerogative of a teacher of beginning or advance geology.

69. Hagner, Arthur F. (1961) "Geologic education and its influence on approaches to geologic problems," Journal of Geological Education, v. 9, no. 2, pp. 89-97.

Students should know something about the various ways in which the interrelated phenomena of geology are currently being studied. Because of the variety and complexity of most geologic processes, no simple method of attack can be successful for all situations. Examples of the approaches being taken by several present-day research geologists are presented. Undergraduate research is suggested as being advisable to increase students' appreciation of the various ways in which geologic problems may be approached.

70. Childs, Orlo C., (1961), "History and forecast of geological training and employment," Bulletin, American Association of Petroleum Geologists, v. 45, no. 8, pp. 1461-70, August.

Presents the results of questionnaires received from 180 colleges and universities and 252 companies or government agencies. Conclusions reached are:

1) MA is min. academic training for geologist in next 5 years.
2) Major oil companies interested only in people coming right from college.
3) Independent and mining companies interested in geologists with 5 plus years experience.

71. Gates, Olcott, (1961, "The geology major in a small college," Journal of Geological Education," v. 9, no. 2, pp. 83-88, Fall.

Geology students need more basic information to succeed in graduate school than a small college can give them under existing course frameworks. This may be remedied by combining courses so as to present the most useful information for the amount of time spent.

72. Prouty, C. E., (1961), "Curriculum Survey," Geotimes, v. VI, no. 3, pp. 28-34, October.

Tabulates the course offerings and degree requirements of 228 geology and related departments giving at least a bachelor's degree.

73. Cooper, Byron N. (1962) "Geology and future employment prospects," Mineral Industries Journal of Virginia Polytechnic Institute, v. IX, no. 2, pp. 1-4.

Although the need for geologists in fuel exploration has declined in the past few years, they should have increasing opportunities in other fields. Those mentioned are: Development of water supplies; stream pollution control; foundations and soils; tunneling and underground construction; highway planning; minerals beneficiation; chemical industries; cement, lime and ceramic industries; coal mining and processing; land evaluation corporate investment counseling; aggregate producing industries; trace-element studies and diagnosis of land chemistry; mineral economics; municipal engineering; local, state and regional planning; coastal engineering; geological counsel on legal problems; oceanography. In beginning classes, the complexity of geology should be played up, not down.

74. Monnett, V. Brown, (1962), "Status of geological education in the United States today," Journal of Geological Education, v. 10, no. 1, pp. 22-27, March.

Discusses decreased student student enrollments pointing out that undergraduates have decreased by as much as 90 percent at some schools.

75. Winchester, John W., (1962), "Undergraduate preparation for the student of geochemistry," Journal of Geological Education, v. 10, no. 1, pp. 13-17, March.

A revamping of undergraduate preparation for geochemists is necessary. Until this is done, students should probably follow a conventional chemical curriculum with some earth science, and undertake geochemical study at the graduate level.

76. McMannis, Wm. J., (1962), "The search for a basic geology curriculum," GeoTimes, v. VI, no. 8, pp. 32-35, May-June.

Tabulates the results of a questionnaire returned by over 100 geologists in various phases of the profession. The following were listed as core courses in a geology curriculum:

Physical geology
Historical geology
General Chemistry
General Physics
College Math.
English composition
Mineralogy
Field geology
Structural geology

## ALPHABETICAL LISTING OF AUTHORS

In the following supplementary list of authors and dates, reference to the principal item in the chronologic list is by reference number following the date

Adkins, John N.,
1947 - 26
Albritton, Claude C., Jr.
1952 - 36
American Association of Petroleum Geologists,
1941 - 7
1942 - 8
1943 - 9
1944 - 10
1948 - 29

Bannerman, H.M. and Pecora, Wm. T.,
1950 - 35
Behre, Chas. H., Jr.,
1953 - 38;
1959 - 62
Boardman, Donald C.,
1957 - 49
Boutwell, John , .,
1945 - 11
Bradley, W.H.,
1947 - 27
Brown, F. Martin,
1959 - 61
Bullard, Fred M.,
1956 - 45

Chapman, Randolph W.,
1951 - 34
Charlier, D.H., and Daley, C.J.,
1960 - 66
Childs, Orlo C.,
1961 - 70
Cohee, George V.,
1956 - 46
Colbert, Edwin H.,
1947 - 20
Cooper, Byron N.,
1958 - 55
1962 - 73
Croneis, Carey,
1956 - 48
1961 - 68

DeGolyer, E. L.,
1940 - 6
Delo, David M.,
1946 - 16

Ecklemann, F. Donald,
1958 - 58
Ellison, Samuel P., Jr.,
1955 - 42

Fan, Paul H.,
1959 - 65
Foose, Richard M.,
1956 - 44
1956 - 47
Fryxell, F.M.,
1948 - 31

Gates, Olcott,
1961 - 71
Gault, H.R.,
1952 - 37
Gilluly, James,
1946 - 13
Ginger, Lyman G., and others,
1958 - 59

Hagner, Arthur F.,
1961 - 69
Hagner, Arthur F., and
Henderson, Donald M.,
1959 - 63
Harbaugh, John W.,
1958 - 57
Hemingway, Caroline E.,
1947 - 24
Hendricks, Herbert E.,
1957 - 51
Hendricks, Thos. A.,
1948 - 30
Horberg, C.L.,
1955 - 41
Horberg, C.L., Olson, E.C.,
and Theil, G.A.,
1950 - 33
Howell, B.F.,
1957 - 52
Hussey, Keith M.,
1957 - 50

Lahee, F.H.,
1938 - 4
Laird, Wilson M.,
1957 - 54
Langenheim, Ralph J., Jr.,
1957 - 53
Leith, C. K.,
1921 - 2
Levorsen, A.I.,
1940 - 5
1946 - 14
Lindgren, Waldemar,
1919 - 1
Longwell, C.R.,
1946 - 17
1946 - 18
1947 - 28
Lougee, Richard J.,
1947 - 25

McCaslin, John C.,
1954 - 40
McKinstry, H.E.,
1946 - 15
1947 - 23
McMannis, Wm. J.,
1962 - 76
Melton, Frank A.,
1947 - 22
Monnett, V. Brown,
1962 - 74
Murray, Grover E.,
1958 - 56

Prouty, C.E.,
1961 - 72

Quirke, Terrance T.,
1947 - 21

Shuler, Ellis W.,
1929 - 3
Smith, H.T.U.,
1947 - 19

Socolow, Arthur A.,
1958 - 60
Stevenson, Robert E.,
1959 - 64

Taylor, Ann Richards,
1946 - 12
Theil, Geo. A.,
1949 - 32

United States Department of Labor
1955 - 43
United States National Science
Foundation,
1953 - 39

Willard, Gates,
1960 - 67
Winchester, John W.,
1962 - 75